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East Europe Report

SCIENTIFIC AFFAIRS

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EAST EUROPE REPORT

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CONTENTS

ACCOMPLISHMENTS IN BIOMECHANICS RESEARCH OUTLINED

Sofia SPISANIE NA BULGARSKATA AKADEMIYA NA NAUKITE in Bulgarian No 2, 82
pp 86-90

[Article by Prof Khristo Khristov: "The 10th Anniversary of the Creation of the Scientific Group on Biomechanics"]

[Text] Biomechanics is a contemporary science which holds a position between mechanics and biology. It studies the mechanics of motion in animals and man under circumstances of the labor and surrounding environments with a view to meeting the requirements of scientific knowledge and contemporary technical progress in various fields of life.

The interest in biomechanics dates from ancient times but it is only of late that it has developed as an autonomous branch of mechanics with its specific problems and application. The importance of biomechanics is related to its growing application in technology, industry, machine building, transportation, military affairs, aerospace studies, underwater activities in the development of the ocean and the sea shelf, the development of the subsoil, sports, medicine, etc., as well as the use of biomechanical principles of action of biological systems in the development of efficient mechanisms, machines, building structures, anthropomorphic and zoomorphic robots and systems, technical models for sensory systems, etc.

Biomechanics is one of the young scientific research directions of mechanics followed in our country. Its creator and manager is Academician G. Brankov, a noted Bulgarian scientist who is known as the founder of the latest developments in the field of mechanics in our country. A scientist with comprehensive interests, high scientific erudition and great organizational talent, he was the first to raise the question of the overall organized development of biomechanics in our country during the early period of its establishment as a science, when unorganized research on some biomechanical problems existed on a worldwide scale only in a few countries. In 1970 Academician G. Brankov submitted to the management of the BAN [Bulgarian Academy of Sciences] a suggestion with a detailed comprehensive program in the field of biomechanics. In August 1970 the Presidium Bureau considered the program and approved the creation of a scientific group on biomechanics. On 11 June 1971 (Protocol No 8, Point 3) the BAN presidium approved the bureau's decision. A scientific group on biomechanics under the BAN presidium was created, headed by Academician G. Brankov (at that time BAN

corresponding member). The problems which the group was to deal with and the membership of the first problem commission were approved at the same session. This decision marked the historical beginning of the development of biomechanics as a scientific trend in our country. Bulgaria became one of the first countries in the world with an independent academic unit in the field of biomechanics, thus outstripping a number of highly developed capitalist countries. In this respect it was also first among the socialist countries.

The rapid development of biomechanics and the possibilities of its use in our country required the making of further changes in the structure of the new unit. A Central Biomechanics Laboratory was created on 16 October 1972 (Order No 372 of the Council of Ministers Bureau, Point 10 of the addendum), as an independent scientific unit under the BAN presidium, which included a Scientific Group on Biomechanics. Academician G. Brankov was elected director of the new unit.

Starting with 1 July 1977 (Council of Ministers Resolution No 64, Section III, Point 13, Appendix No 2, dated 1 July 1977, DV No 66) the Central Biomechanics Laboratory and the mechanics units of the Institute of Mathematics and Mechanics of the Unified Center of Mathematics and Mechanics became the Institute of Mechanics and Biomechanics (IMB) under the BAN, with Academician G. Brankov as its director.

This was the chronology in the organizational development of biomechanics in our country to this day, starting with the creation of the Scientific Biomechanics Group 10 years ago.

The initial scientific research biomechanics units were problem groups whose basic purpose was to study human systems. Following their transfer to the Institute of Mechanics and Biomechanics, the problem groups became sections which retained their initial systems orientation and research projects--man in his labor environment, as follows: biomechanics of the cardiovascular system; biomechanics of the motor system; biomechanics of the vestibular system; laboratory for the manufacturing of scientific instruments, manipulators and robots; biorheology; electromechanical interaction in biological environments; and others.

Within the IMB system, particularly after undertaking new assignments based on the plans for the development of our country during the Seventh Five-Year Plan, the IMB management had to energize the activities of instrument manufacturing, and, more specifically, bioengineering developments. To this effect, in 1981 (by decision of the BAN presidium, Protocol No 5, Point 2.3, dated 21 May 1981), a Section on Instrument Manufacturing and Robotics with a laboratory for voice relations between man and machine was created on the basis of the facilities of the Laboratory for Scientific Instrument, Manipulator and Robot Manufacturing.

By decision of the Work Group of the BCP Central Committee Secretariat, dated 10 July 1981, the resolution of the Presidium Bureau and BAN Scientific Secretariat (Protocol No 12, Point 1.1.3, dated 17 July 1981) and Letter No 91-BP-28 of 24 August 1981 and Protocol No 26, Point 1.2.1 and Point 1.2.2

of the ETsMM [United Center for Mathematics and Mechanics] Council, dated 11 September 1981, a provisional Problem Group on Prostheses and Anthropomorphic Robots was developed within the IMB. On the basis of the same decisions the Section on Biomechanics of the Motor System was reorganized into the Section on Biomechanics of Motions, Exoskeletals and Manipulators under the IMB, with emphasis on bioengineering.

The development of biomechanical research starting with 1971 and to this day has shown unquestionable progress in terms of topics, scope, scientific ideas, standards and applied signficance. The common features of the topics covered during the past 10 years is that they relate to tasks which are based on reality and are made necessary by the development of technical progress. From the topical viewpoint the studies conducted during that period covered the following areas:

Technology, industry, transportation, construction, etc., which face the "man-operator-machine" problem. Studies are made of mechanical influences on man under normal and extreme pressures, high speeds, pressures created by linear and radial accelerations, hyperbaric loads, mechanical loads of various natures, impact of power flights, optokinetic influences and other factors whose influence defines human behavior in his labor environment and triggers a variety of changes at first to man's health and ability to function;

Bioengineering (instrument and structures), related to the use of the principles of biological systems for the creation of new machines, mechanisms, structures, exoskeletons, manipulators, etc.;

Medicine and medical technology. This involves the use of mechanical-mathematical methods in diagnosis, therapy and prophylaxis; determination of criteria which guarantee the health, life and security of man in his labor environment; problems related to protective means against mechanical influences; problems related to prostheses and artificial organs, mechanical characteristics of organs and tissues, etc.

The assignments formulated in the theses of the 12th BCP Congress were of decisive importance in terms of the direction of biomechanical talks. This applied in particular to problems of automation and mechanization of production processes, replacing unattractive, dangerous and hard physical labor with machines, increasing man's physical strength with exoskeletons, etc.

The application of biomechanics in robotics became particularly topical with the creation of anthropomorphic and zoomorphic robots and manipulator systems which imitate man's movements (for work with dangerous technologies), robot systems for underwater activities, etc.

The specific nature of the tasks set at different stages to the biomechanical units has always required a comprehensive approach to their solution. To a certain extent, this determines the development of the organizational

structure and the personnel. We are currently following the basic biomechanical directions which enable us to engage in serious basic scientific research and applied activities in virtually all areas.

The scientific series "Biomekhanika" [Biomechanics], with Academician G. Brankov as responsible editor, has been published since 1974. This is the first specialized publication of its kind in the socialist countries and among the first in the world. So far 12 booklets, which have been the subject of great interest abroad as well, have been published. They have included a considerable number of articles by noted scientists from the USSR, Poland, Czechoslavakia, the United States, France, Canada, Italy and others. The proceedings of the First National Conference on Biomechanics, which was held in Bulgaria in 1972, were published as a separate collection, in English, in 1973. The proceedings of our national congresses on theoretical and applied mechanics include studies conducted by Bulgarian scientific workers on biomechanics. Bulgarian studies in biomechanics have been published in noted foreign periodicals, collections of symposia, international congresses and others in the USSR, the United States, France, England, Poland, Czechoslovakia and others.

The papers presented by the Central Biomechanics Laboratory at the "Euromech '68" Colloquium on mechanics of solid deformed biological bodies were published in a special collection in English. A collection containing materials from the Franco-Bulgarian seminar on "Biomechanics and Informatics in Functional Cardiological Research" was published in French. In 1978 the first monograph of its kind, both domestically and abroad, on "Osnovni Vuprosi na Biomekhanikata" [Basic Problems of Biomechanics] by Academician G. Brankov was published in 1978. In 1981 the same monograph was published in Russian in the USSR (Mir Publishing House, Moscow). The monograph extensively discusses directions followed in the development of scientific research on human biomechanics. The monograph was rated highly by noted foreign and Bulgarian scientists and specialists.

Ever since it was established in 1971 and to this day, the biomechanic area, thanks to the efforts of its director and the concern of the BAN management and the Unified Center on Mathematics and Mechanics, has engaged in active efforts related to the organization and implementation of scientific measures of national and international nature. The First National Conference on Biomechanics was held in our country in December 1972; the European "Euromech '68" Colloquium (with 53 foreign participants from 11 countries) was held in our country in September 1975; the Franco-Bulgarian "Biomechanics and Informatics in Functional Cardiological Research" was held in September 1978. Our personnel actively participated in national congresses on mechanics in 1973, 1977 and 1981, in the area of biomechanics.

The First Summer School on Biomechanics was held under the guidance of Academician G. Brankov in 1975. It involved the participation of 10 lecturers and 37 students from 8 European and American countries. A summer school on "Biomechanics in Robotics," with the participation of foreign lecturers and students, is being prepared for 1982.

Active bilateral and multilateral cooperation in the field of biomechanics is under way with the academies of sciences of the socialist countries such as the USSR Academy of Sciences Institute on Problems of Mechanics, USSR Academy of Sciences Institute of Machine Building, Latvian SSR Academy of Sciences Institute on Polymer Mechanics, USSR Academy of Sciences Siberian Department Institute of Hydrodynamics, Czechoslovak Academy of Sciences Institute of Hydrodynamics, Czechoslovak Academy of Sciences Institute of Theoretical and Applied Mechanics, Polish Academy of Sciences Institute of Biocybernetics and Bioengineering, and others.

Scientific cooperation is under way with universities and institutes in England, the United States and others. Currently, the IMB is coordinating the topic "Biomechanics" as part of the plan for multilateral cooperation among the academies of sciences of the socialist countries. Cooperation is also under way along the Intercosmos line. Close contacts have been established with scientists in the USSR, Czechoslovakia, Poland, Yugoslavia, Greece, England, France, and others.

The biomechanics personnel maintain close relations with many institutes of the Bulgarian Academy of Sciences, the Medical Academy, the V. I. Lenin Higher Machine-Electrical Engineering Institute in Sofia, and others.

The 10th anniversary of the creation of the Scientific Group on Biomechanics was celebrated in 1981. This was the first scientific research biomechanics unit in our country. It was a period of organizational development and consolidation, personnel development and arrangement of topics, which included the results of meaningful scientific research.

The biomechanical collective at the IMB celebrates with particular pleasure its 10th anniversary, expressing its gratitude to the BAN leadership for its concern for biomechanics and pledges to make its worthy contribution to the implementation of the tasks set by the 12th BCP Congress to Bulgarian science.

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REGULATION GOVERNING SAFE PACKING, TRANSPORTATION OF USED NUCLEAR FUEL

Sofia DURZHAVEN VESTNIK in Bulgarian 24 Aug 82 pp 826-831

[Committee for the peaceful utilization of atomic energy Ordinance No 5 on securing nuclear safety in the transportation of spent nuclear fuel]

[Text] Ministries and other departments

State Committee for Science and Technical Progress

Committee for the Peaceful Utilization of Atomic Energy

Ordinance No 5 on Securing Nuclear Safety in the Transportation of Spent Nuclear Fuel

Chapter 1

General Stipulations

Article 1. The present ordinance defines the technical and organizational requirements governing the securing of nuclear safety in the transportation of spent nuclear fuel.

Article 2. The purpose of ensuring nuclear safety in the transportation of spent nuclear fuel is to prevent the following:

1. The formation of a critical mass;

2. The destruction of the wrapping of the spent nuclear fuel above admissible levels.

Article 3. The ordinance shall not apply in the following cases:

1. Transportation of spent nuclear fuel within the organization in which it used;

2. Transportation of "fresh" nuclear fuel;

3. Radiation safety control.

Article 4. The organizations in charge of transporting spent nuclear fuel shall issue internal regulations ensuring nuclear safety in accordance with the present ordinance.

Chapter 2

Packaging Sets

Article 5. Spent nuclear fuel will be transported in packaging sets type B as per BDS [Bulgarian State Standard] 10473-72.

Article 6. The design of the packaging set must be such as:

1. To exclude the possibility that the spent nuclear fuel may melt;

2. To have a reliable system for hermetic sealing which will prevent its opening accidentally or as a result of pressure which may develop within it;

3. To ensure its firm fastening to the transportation facility during the transportation and its safe shifting with hoisting mechanisms.

Article 7. All systems added to the packaging set in the course of the transportation, which are not part of it, should not affect its safety.

Article 8. Should the packaging set include neutron absorbers, its structure should be such as to provide for the possibility of checking their existence, quality and distribution.

Chapter 3. Packaging

Section I

General Stipulations

Article 9. The packaging sets with the spent nuclear fuel they contain shall be classified as follows from the viewpoint of nuclear safety:

1. Grade 1 packaging--safe from the nuclear viewpoint in a limited number, arbitrarily located and under all possible predictable transportation conditions;

2. Grade 2 packaging--safe from the nuclear viewpoint in a limited number, arbitrarily located and under all possible predictable transportation conditions;

3. Grade 3 packaging--safe from the nuclear viewpoint under all foreseeable transportation conditions because of special precautionary measures taken or as a result of special measures for administrative control during the transportation.

Article 10. The maximum temperature of each accessible surface of the packaging during the transportation of the spent nuclear fuel may not exceed $55^{\circ}K$ ($82^{\circ}C$) under normal transportation conditions.

Article 11. The maximal effective pressure on the packaging should not exceed 0.7MPa (7 kg-force per square centimeter).

Article 12. In order to exclude the appearance of an uncontrolled change reaction in the transportation of spent nuclear fuel, any given type of packaging must meet one of the following conditions:

1. The mass of fissile materials in the packaging must not exceed the admissible level, i.e., 80 percent of the critical mass of the system under both normal or breakdown transportation conditions;

2. The effective coefficient of neutron multiplication in the packaging must not exceed 0.95 under normal or breakdown transportation conditions.

Article 13. Unless proof can be provided that the melting of the fuel cannot take place, the overall quantity of the fissionable material in the packaging must not exceed the critical mass of the melted fuel.

Section II

Additional Stipulations for Grade 1 Packaging

Article 14. In the case of grade 1 packaging, nuclear safety in transportation is provided by the structure of the packaging set.

Article 15. The packaging structure, based on tests under normal and breakdown transportation conditions, should meet the following stipulations:

1. No water should be able to pass through the packaging if no such penetration is stipulated in the transportation conditions. Should conditions be created for the sifting of water into the packaging, not stipulated in the study on securing nuclear safety, the effective neutron multiplication coefficient must not exceed 0.95;

2. The shape of the content and the geometric shape of the packaging set (taking elastic deformations into considerations), must not change in such a way that the effective neutron multiplication coefficient exceeds 0.95 or the quantity of fissionable substances in the packaging exceeds 80 percent of the critical mass of the system;

3. The following must remain under subcritical conditions:

a) A group of undamaged packaging of the same design, regardless of quantity or location;

b) A group consisting of damaged packaging not to exceed 250 units of the same design, arbitrarily located and surrounded on all sides by a minimal distance of a water reflector. In such cases the existence of a hydrogen-containing delaying factor between the packaging and the penetration of water in the packaging should be taken into consideration should this lead to an increase in the reacting nature of the system.

Article 16. If according to the stipulations of radiation safety the thickness of the wall of the packaging set is equal to or exceeds 0.15m, such packaging shall be considered properly insulated from neutron interaction and, in accordance with Article 15, points 1 and 2, shall be classified as grade 1.

Section III

Additional Stipulations for Grade 2 Packaging

Article 17. Putting together grade 2 packaging in the stipulated area in a quantity larger than the one indicated in the accompanying documentation or certificate is forbidden.

Article 18. The design of the grade 2 packaging must meet the additional requirements stipulated in Article 15, points 1 and 2.

Article 19. (1) In each grade 2 packaging design the admissible number of packagings and groups arbitrarily located in the course of the transportation must be determined as a result of computations or experimentations based on the lowest possible number;

1. One-fifth of the critical number of undamaged packaging, or

2. One-half of the critical number of damaged packaging surrounded on all sides by a minimal distance of a water reflector.

(2) The existence of water-containing delaying agents between the packaging and the penetration of water in the packaging must be taken into consideration should this trigger any increase in the reactivity of the system.

Section IV

Additional Stipulations for Grade 3 Packaging

Article 20. Grade 3 packaging applies to packaging which does not meet in full the stipulations of Section I of the present chapter.

Article 21. Particular safety and control measures must be taken for grade 3 packaging which would prevent dangerous damaging of the packaging under any kind of foreseeable transportation conditions.

Article 22. Combined with the special transportation safety measures, the design of grade 3 packaging must meet the general stipulations on nuclear safety as per article 37.

Article 23. Special transportation measures shall be drawn up specifically for each type of packaging on the basis of a study of deviations from requirements concerning grade 1 and grade 2 packaging. Such measures must include the following:

1. Technical measures which prevent inadmissible damaging of the packaging;

2. Administrative measures which create special transportation conditions which would exclude breakdowns;

3. Efficient control measures regarding the condition of the packaging and its structural components before it has been filled and during the transportation.

Chapter 4

Stipulations Governing Packaging Set Tests

Section I

General Stipulations

Article 24. (1) The packaging set used in transporting spent nuclear fuel must undergo the tests stipulated in Articles 27-31, Section II, and Articles 32-36, Section III.

(2) The tests stipulated in the preceding paragraph may be made in accordance with one of the following methods or combination of methods:

1. Computations (mathematical modeling) of damage caused to a specific packaging set;

2. Tests of models or prototypes of packaging sets.

Article 25. The following must be obtained as a result of tests of packaging sets:

1. Data on possible losses of the material contained in the packaging and the absorbance, the integrity of heat-releasing elements, structural materials, figures on changes in the geometric shapes of the system, dimensions of temporary deformations (tighter packing, bending, etc.) in tests of mechanical strength and sealing of the containers;

2. Data on changes and absorbing agents, heat-release elements and structural materials (integrity, melting, changes in geometric shape) in tests modeling fire conditions;

3. Data on the amount of water which has penetrated into the packaging in tests of dumping the packing in water.

Article 26. A copy of the tests must be added to the packaging set certificate.

Section II

Packaging Set Tests Under Normal Transportation Conditions

Article 27. Packaging set tests under normal transportation conditions must mandatorily include:

1. The pouring of water;

2. Free fall;

3. Pressure;

4. Shock.

Article 28. The water pouring test is considered satisfactory if the following conditions are met:

1. The amount of water per unit of area must equal the amount of water from rain precipitation equaling 0.05 meters per hour;

2. The water must be poured on the sample at a 45 degree angle compared with the horizon;

3. The water must be distributed almost evenly as is the case during natural precipitation along the external surface of the sample, in the direction of the jet;

4. The sample must be placed in a position which presumes the strongest possible effect of the studied details;

5. The sample must be placed in such a way that no water can collect around it.

Article 29. In a free fall test, the sample should be thrown against the target in such a way as to cause the maximally possible damage to the tested safety parts. The height of the free fall, measured from the lowest point of the sample to the upper surface of the target must be no less than 1.2 meters; should the sample weigh in excess of 5,000 kilograms, the fall distance should be no less than the distance indicated in Appendix No 1.

Article 30. The pressure test must include the following:

1. For 24 hours the sample must be subjected to pressure equal to the higher of the following figures:

a) The equivalent of the weight of the actual packaging multiplied by a factor of 5;

b) The equivalent of 13,000 MPa (1,300 kg force per square meter), multiplied by the vertically projected area of the packaging;

2. The patenting must be divided evenly between the two opposite sides of the sample, one of which is considered the base on which the packaging rests.

Article 31. The shop test calls for the sample to be set on a hard flat horizontal surface. A stick 32 millimeters in diameter with a semi-round end, weighing 6 kilograms, must be thrown at the sample from a 1 meter height from the lower end of the stick to the upper surface of the sample. The stick must be thrown vertically in the direction of the center of the most vulnerable part of the samples so that, should it pierce the sample at a sufficient depth it may reach the sealing system as well. The testing rod should not be significantly misshaped.

Section III

Testing the Packaging Set Under Transportation Breakdown Conditions

Article 32. The tests to which the packaging set must be subjected under transportation breakdown conditions must mandatorily include the following:

1. Mechanical damage;

2. Heat;

3. Dumping in water.

Article 33. The mechanical damage test must consist of two falls on targets in such a way as to cause the most severe damage possible on the sample:

1. In the first fall the sample must fall on the target in such a way as to result in maximal damages and the height of the fall from the lowest point of the sample to the upper surface of the target should be 9 meters;

2. In the second fall the sample must fall on the target in such a way as to result in maximal damage and the height of the fall, measured from the presumed area of the strike of the sample to the upper surface of the target equal one meter.

Article 34. The heat test is considered satisfactorily passed when the entire sample is subjected to heat radiation for 30 minutes at a temperature of 1073^{o}K (800^{o}C) with a 0.9 emission coefficient. Following the external heat applied on the sample, the following two conditions must be met:

1. The sample must not be artificially cooled for the next 3 hours;

2. The burning of the material of the sample should not be terminated for the next 3 hours unless it ends sooner by itself.

Article 35. The dumping test calls for the sample to be placed in a depth of no less than 15 meters and be kept there for no less than 8 hours.

Article 36. The stipulation that when dumped in water the sample is located in a depth of no less than 0.9 meters and remain in that position no less than 8 hours in a way in which the maximal penetration of water may be expected applies only to grade 1 and grade 2 packaging in which water penetration increases the reactiveness of the system.

Chapter 5

Transportation Conditions

Article 37. Spent nuclear fuel must be transported in such a way that under regular or irregular transportation conditions no critical states develop and no damage may affect the covering of the heat-releasing elements within a single packaging set or groups of packaging sets. To this effect the following must be taken into consideration:

1. Penetration of water in the packaging set or loss of heat carrier from the packaging set;

2. Reduced efficiency of the absorbing agents installed in the packaging set or neutron inhibitors;

3. Possibility of regrouping the content into systems which can better react both within and outside the packaging set;

4. Reducing the distance between the packaging sets or between their content;

5. Possible increase in reactiveness as a result of changes in the temperature of the content of the packaging set;

6. Other reasons which may result in any damaging of the cover of the heat-releasing elements.

Article 38. If the radiation level of the spent nuclear fuel is unknown and its reactiveness is reduced in combustion, it is considered as non-radiated. Should its reactiveness increase in combustion, it is considered radiated to the highest level. If the degree of radiation of the spent nuclear fuel is known its reactiveness must be assessed.

Article 39. In loading the packaging set with cassettes containing heat-releasing elements, the organization which handles the spent nuclear fuel must:

1. Inform the personnel of the instructions regarding their obligation during the transportation, holding tests to this effect and allowing only those who have passed them successfully to transport the fuels;

2. Test the readiness of all hoisting installations with which the packaging will be lifted;

3. Check the suitability of the transportation facilities which will transport the spent nuclear fuel;

4. Check the seal of all cassettes containing heat-releasing elements to be transported;

5. Check the distribution of neutron absorbers if such are included in the packaging set;

6. Draw up a program for charging the packaging set with cassettes containing heat-releasing elements;

7. Compute the heat for each packaging.

Article 40. After the packaging has been loaded with the cassettes with heat-releasing elements, the organization which manages the spent nuclear fuel must:

1. Establish the parameters of the packaging to the point where a balanced state has been reached;

2. Test and examine the packaging in accordance with the requirements of the operational instruction attached to the packaging;

3. Set up a table indicating the parameters of the packaging as per Appendix No 2;

4. Check the effectiveness of the neutron protection of the packaging, which stipulates the availability of neutron absorbers.

Article 41. The organization managing the spent nuclear fuel must meet the following stipulations in the loading and transportation of the packaging:

1. The packaging sets filled with spent fuel must be reliably fastened in order to prevent the overturning or shifting of the packaging in road turns, pushing, stopping or rocking;

2. The sum total of transportation indicators must not exceed 50 in determining the number of packagings for transportation by rail, truck or water;

3. In the case of sea vessels, the number of packagings must be restricted in such a way that the sum total of transportation indicators per hold must not exceed 50 while the sum total aboard tha vessel does not exceed 200;

4. In the case of sea vessels, if the sum total of transportation indicators per group packages does not exceed 50 and the distance between each group is no less than 6 meters, the sum total of transportation indicators of packagings within a single hold may not exceed 200 without limitations regarding their overall number aboard the same vessel;

5. When the entire hold or deck or entire ship is used by a single shipper, i.e., for the transportation of a full load, the restrictions stipulated in points 2, 3 and 4 no longer apply providing that the number of grade 2 or grade 3 packagings with fissionable substances do not exceed the admissible number.

Article 42. Should the packaging be damaged during the transportation, the transportation may continue after repairs have been completed and the packaging is classified as grade 3. The Committee on the Peaceful Use of Atomic Energy, the Ministry of Public Health and the Committee for the Protection of the Environment must be informed of the accident immediately.

Article 43. (1) Permission for the transportation of spent nuclear fuel is issued on the basis of a written request submitted by the organization managing the fuel, the documentation submitted by it as per Article 44 and a docimetric protocol issued by the organs of the Ministry of Public Health.

(2) The documents stipulated in the preceding paragraph must include the following:

1. A certificate accompanying the documentation on the basis of which it was issued and which contains the following information:

a) Detailed description of the spent nuclear fuel with data on its physical and chemical condition and nature of radiation--a passport of the cassettes containing heat-releasing elements;

b) Detailed description of the structure and the materials of which the packaging is made;

c) Results of conducted tests;

d) Corresponding instructions on utilization and repairs in the use of the packaging;

e) Study of the nuclear safety based on all foreseeable transportation conditions related to the characteristics of the spent nuclear fuel;

f) Special conditions related to ensuring the safe dispersal of the heat released by the packaging;

g) Considerations justifying the selected transportation method and types of transport facilities;

h) A 0.2 x 0.3 meter drawing indicating the structure of the packaging;

2. A protocol certifying that the personnel is familiar with the instructions related to its obligations in the transportation of the spent nuclear fuel;

3. Protocols on the condition and testing of the hoisting equipment used in lifting the packaging;

4. Protocol on the readiness of the transportation facilities used in hauling the spent nuclear fuel;

5. Protocol on the control and tests of the packaging in accordance with the stipulations of the instruction on the use of the packaging;

6. Protocol on the sealing of the cassettes containing heat-releasing elements;

7. Table showing the parameters of the packaging as per Appendix No 2;

8. A chart on the loading of cassettes with heat-releasing elements in the packaging set.

(3) the documents as per point 1 of paragraph 2 shall be submitted to the Committee for the Peaceful Utilization of Atomic Energy 15 days prior to the beginning of the transportation; documents related to the remaining items of paragraph 2 shall be submitted to the inspector on site.

Additional Stipulation

No 1. The meaning of some terms used in the present ordinance shall be the following:

1. In the sense of the present ordinance, "spent nuclear fuel" shall mean fuel cassettes with heat-releasing elements extracted from the reactor following their radiation;

2. "Packaging" shall refer to the packaging set with the spent nuclear fuel within it, ready for transportation;

3. The term "packaging set" shall mean the sum total of components and systems needed for ensuring the safe transportation of the spent nuclear fuel. The set may consist of one or several items, absorbing substances, separating grids, cooling systems, shock absorbers, a system for fastening to the transportation facility, and others;

4. The term "admissible number of packagings" shall mean the maximum number of packagings of grade 2 and grade 3 with spent nuclear fuel, which may be grouped together in the same area of the transportation facility during the transportation process;

5. The term "transportation index (indicator) of the packaging" means:

a) The figure expressing the maximal level of radiation in mber/hour at a distance of 1 meter from the outside surface of the packaging or

b) In grade 2 and grade 3 packagings with fissionable substances, the highest of the following numbers: the number expressing the maximum level of radiation, as stipulated in letter "a" and the number obtained in dividing the admissible number of such packagings by 50;

6. The term "critical mass" is the mass of the spent nuclear fuel at which a fission chain reaction appears;

7. The term "fissionable material" is material which contains fissionable nuclides in the course of the handling of which a fissionable chain reaction may develop.

Final Stipulation

No 2. The present ordinance is issued on the basis of Article 2 of the Ukase on State Control of Nuclear Safety (DV, No 54, 1980) and is binding to all ministries and other departments and organizations.

Chairman: N. Papazov

Appendix No 1 to Article 29

Height of Free Fall in Packaging Weighing Over 5,000 Kilograms

No	Packaging Weight, kg	Height of Free Fall, m
1	From 5,000 to 10,000	0.9
2	From 10,000 to 15,000	0.6
3	15,000 and over	0.3

Appendix No 2 to Article 40, Point 3, and Article 43, Paragraph 2, Point 7

Packaging Parameters

See A, page 830

Key:
1. Number of packaging
2. Estimated sum total packaging activeness
3. Becquerel
4. Computed residual heat release in packaging
5. kvt
6. Temperature of heat carrier in the packaging
7. Pressure of heat carrier in the packaging
8. MPa
9. Maximal depth of combustion in the packaging
10. $\frac{\text{MVt x day}}{\text{kg x U 5}}$
11. Number of cassettes with TOE in the packaging
12. Number
13. Initial enrichment of the spent nuclear fuel
14. Note..pa

Ordinance No 6 on Accounting and Storing Nuclear Material in the Bulgarian People's Republic

Section I

General Stipulations

Article 1. The present ordinance establishes the procedure for accounting and control over the storing of nuclear material in the country, used for peaceful purposes, in accordance with the obligations based on the accord and additional agreement concluded between the Bulgarian People's Republic and the international nuclear energy agency (MAAE) on the application of guarantees related to the Treaty on the Nonproliferation of Nuclear Weapons.

Article 2. The purpose of the accounting and control over the storing of nuclear material is the following:

1. To prevent its use for purposes other than those stipulated;

2. Its prompt discovery and recovery should it be lost;

3. The prevention of radiation risk to the population and the environment.

Article 3. The ordinance does not apply to materials obtained as a result of ore mining and processing activities in the country or nuclear materials crossing the territory of the Bulgarian People's Republic and materials owned by other countries and transported in foreign countries by Bulgarian transport facilities.

Article 4. The organizations which use or store nuclear materials shall formulate internal regulations governing the accounting, storing and control over the movement of nuclear material in accordance with the present ordinance.

Section II

Accounting and Storing of Nuclear Material

Article 5. (1) Organizations which use or store nuclear material temporarily or permanently must:

1. Draw up the following reports:

a) Inventory changes (respectively R.01.1 for receiving and R.01.2 for shipping nuclear material), submitted to the Committee for the peaceful utilization of atomic energy (KMIAE) no later than 20 days after any change has occurred in the inventory quantity of the nuclear material;

b) On the nuclear material on hand in the respective area of the material balance--R.02/c;

c) Material-balance--at the end of the specific accountability period--R.03;

d) Reports as per letters "b" and "c" must be submitted to the KMIAE no later than 20 days following the month during which the physical inventory has been taken;

2. The following books must be kept:

a) Main accounting book in which the movement of nuclear material in the direction of the material balance area and back must be recorded;

b) Fresh fuel book in which the availability of nuclear material in the fresh fuel warehouse is recorded. Such books must be kept for each warehouse separately;

c) Book on the active area of the reactor in which the nuclear material in the active area of each reactor is recorded;

d) Book on spent nuclear fuel in which the movement of the nuclear fuel in the deposit basins is recorded;

e) Inventory book on fuel cassettes by number, type and concentration;

f) Report card on fuel cassette--showing the movement of the nuclear fuel and the specific status and position of each cassette separately;

g) Book on the transportation of the spent nuclear fuel in order to register the nuclear fuel taken out of the country.

(2) Report as per point 1 of paragraph 1 and books as per point 2 of paragraph 1 must be kept for periods of no less than 5 years.

Article 6. Should justifiable grounds exist to the effect that nuclear material may be lost or damaged as a result of unexpected events, in accordance with Article 5 paragraph 1 the organizations must inform their superior organ, the KMIAE and the Ministry of Internal Affairs within 48 hours after the discovery that the material has been lost or damaged or after the possibility of its loss or damaging may arise. The reasons for the incident must be described in a special report in which the measures taken for the prevention of incidents must be indicated. The report must be submitted to the stipulated organs within 15 days following the incident.

Article 7. The organizations which use or store nuclear material must inform the KMIAE and the Ministry of Internal Affairs 15 days in advance in the following cases:

1. Forthcoming planned changes in the available quantities of nuclear material or operations which may bring about any damaging or breaking of the KMIAE or MAAE seal;

2. The transfer of nuclear material to other organizations. In such cases the following information must be supplied:

a) Data on the quantity and composition of the nuclear material;

b) The date and place of packaging and unpackaging of the shipment;

c) The name and address of sender and receiver;

d) Date of sending or receipt of shipment;

3. Stopping the nuclear energy installation for reloading, indicating the planned date at which the installation will be ready for inspection by the MAAE. The permission of the KMIAE and the Ministry of Internal Affairs for closing the active zone must be requested no less than 5 days before the closing down of the area.

Article 8. Organizations which expand nuclear installations they manage must submit expansion data to the KMIAE no less than 6 months prior to the commissioning of the new facilities.

Article 9. Complete physical inventory must be made of the nuclear material in the nuclear installation; their interval and method must be determined by the KMIAE.

Article 10. The organization receiving nuclear material for the first time must coordinate in advance with the KMIAE the means for its accounting and storage control. The information must be submitted to the KMIAE 6 months before the commissioning of the new nuclear installation.

Article 11. The organization which uses or stores nuclear material must assign suitable personnel in charge of accounting and storage of the nuclear material.

Article 12. The officials in charge as per Article 11 must ensure the practical implementation of the obligations on accounting and storing the nuclear material in nuclear installations.

Article 13. Organizations which import or export nuclear materials in quantities exceeding one actual kilogram or which will import or export several individual parcels within a 3-month period, each one of which is under one actual kilogram but the sum total of which exceeds one actual kilogram must submit advance information of this fact to the KMIAE on such transfers no later than 3 weeks prior to the time the parcel has been shipped or received by the nuclear installation. In a combined shipment the deadline must precede the final shipped quantity which will total one actual kilogram. The information must include the data stipulated in Article 7, point 2.

Article 14. In the case of nuclear material exported from the Bulgarian People's Republic to a country in which nuclear material is not subject to MAAE control, the contract must stipulate the obligation of the competent authority of the receiving country to notify the MAAE of the acquisition of nuclear material.

Section III

Nuclear Material Control

Article 15. Overall control of nuclear material in the Bulgarian People's Republic is provided through systematic inspections. The inspections may be internal--conducted by the KMIAE--and international--by the MAAE. The KMIAE inspectors enjoy the privileges stipulated in the Ukase on State Control of Nuclear Safety (DV, No 54, 1980), and the regulation governing its application (DV, No 8, 1981).

Article 16. The MAAE inspectors, approved in accordance with the proper procedure by the competent authorities in the Bulgarian People's Republic shall be given access to the sites to be inspected only if accompanied by a KMIAE inspector.

Article 17. The organizations which use or store nuclear material must assist the KMIAE and MAAE inspectors in their inspections. They must put at their disposal equipment and personnel for measuring the nuclear material, facilities for handling and observing them and the necessary energy to power them.

Article 18. Liaison between the MAAE inspectors and the organizations which use or store nuclear material subject to accounting and moving, shall be provided by a KMIAE inspector.

Additional Stipulation

No 1. The term "nuclear material" in the sense of this ordinance shall apply to:

1. Natural uranium, uranium reduced in terms of isotope 235, thorium and its alloys, and chemical compounds and concentrations of such metals in a physical or chemical form which allows the separation of the fissionable isotope or the production of combustible elements;

2. Plutonium 239, uranium 233, uranium enriched with isotopes 233 and 235, or any other type of materials which may contain one or several of these elements.

Final Stipulation

No 2. The present ordinance is issued on the basis of Articles 3 and 26 of the Regulation on the Application of the Ukase on State Control of Nuclear Safety (DV, No 8, 1981).

Chairman: N. Papazov.

5003
CSO: 2202/19

MICROCOMPUTER SYSTEM SM 50/40-1 (SM 1 265) DESCRIBED

Prague VYBER INFORMACI Z ORGANIZACNI A VYPOCETNI TECHNIKY in Czech No 3, 1982
pp 275-281

[Article by Vladimir Hanus: "The SM 50/40 (SM 1 625) Microcomputer System"]

[Text] This system represents in practice the series of modules, designs and problem-oriented systems for use in controlling technological processes and terminals within hierarchical systems, for data acquisition and preprocessing, for running administrative routines, etc. The core of the system is an 8-bit microcomputer of small dimensions that can be used either as an independent system or can be built into other equipment. The following modules have already been developed, documented and tested for this compact and low-cost system:

--SM 2138 -. a single-board microcomputer, the basic module;

--SM 0440 - a 16K-byte NMOS main memory;

--SM 0449 - a 16K-byte semiconductor EPROM permanent memory;

--SM 2150 - a programmable serial adapter module;

--A nonstandard interface module;

--SM 2151, SM 2152 - external floppy-disk memory controllers;

--An 8-bit analog output module;

--A 12-bit analog output module;

An optically isolated discrete input/output module.

The documentation and testing are being completed (as of yearend 1981) of the following additional modules:

--SM 0441 - a 16K-byte CMOS main memory with reserve battery;

--SM 0442 - a combined memory with 64K bytes NMOS + 16K bytes EPROM;

--SM 2142 - a combined memory with 8K bytes of static RAM + 8K bytes of EPROM;

--SM 2165 - a programmable parallel adapter module;

--SM 2170 - a high-speed mathematical processor module;

--An analog-to-digital converter module;

--A low-level multiplexer module;

--A high-level multiplexer module;

--A counter input module;

--A pulse output module;

--An interrupt input module.

The developed mechanical units permit installation of the microcomputer system's modules in machinery or equipment, in 19-inch bays or racks, or in desk-type or desk-top microcomputer systems.

For direct installation in machinery there is a single or double housing with power supply, cooling fan, space for five or ten modules, and a simple control panel. It is easy to interconnect up to three housings by means of connectors, so as to form a larger configuration. For example, a housing for the 2/3 SMEP [System of Small Electronic Computers] board measuring 280 x 240 mm is used in the architecture of the intelligent CRT terminal (discussed below). For the desk-top model a 19-inch cabinet is used with a designed cover that can accomodate up to 16 modules. A similar enclosure is available for an external floppy-disk memory with two Consul 7112 drives built into a 19-inch cabinet, so that it can be built also into the standard SMEP rack or cabinet or, for the desk-type model, into an ordinary office desk, together with the SM 50/40-1.

One of the variants is the MVS (Microcomputer Development System) as a problem-oriented configuration for the development of programs and applications (see below), based on an intelligent CRT terminal. There is also another configuration variant that can be used for word processing as well.

The SM 2138 basic module contains the following:

--Its own I 8080-based microprocessor that can access up to 64K bytes of memory;

--System bus driver;

--2K-byte static RAM block;

--4K-byte EPROM block;

--Serial interface for one peripheral with an IRPS communication line;

--Parallel interface for one input-output peripheral or for two input or output peripherals;

--Programmable timer;

--Interrupt controller.

With a total of 72 basic instructionsone, two or three bytes long, it is possible to address the operands in three modes. The set of instructions is divided into transfer, arithmetic, logical, and branch instructions for the branching of the input, output and store instructions. The average execution time of an instruction is 2 to 8.5 μsec. There is an eight-level basic priority interrupt system. Interrupts are handled by an integrated circuit that generates the priority interrupt vector.

The 16K-byte NMOS-RAM main memory is a dynamic memory with an access time shorter than [number missing] nsec, and a write-and-read cycle shorter than 640 nsec.

The 16K-byte EPROM is a programmable permanent memory for the permanent storage of information. It has an access time shorter than 550 nsec.

The programmable serial adapter module permits connecting four input/output devices to an IRPS or S 2 communication line. In the synchronous or asynchronous mode the program selects the transfer rate which may be up to 9600 bps.

With the nonstandard interface (peripheral interface converter) module it is possible to connect an FS 1501 A/M punched-tape reader, a DT 105 S tape punch, and a Consul 2111 matrix printer.

With the external floppy-disk memory controller it is possible to add a random access memory in the form of twin disk drives, with a total capacity of 512K bytes. It has an output to the I-41 system interface.

The 8-bit analog output module provides for the output of eight separate analog signals into the environment. It converts the microcomputer's digital data into analog signals that are then inputs into the controlled environment.

The 12-bit analog output module is able to send four analog signals of greater precision to the controlled environment.

The optically isolated discrete input/output module permits the input or output of 48 discrete signals into or from the system. In accordance with the number of inputs and outputs, it is possible to select variant A for 24 inputs and 24 outputs, variant B for 32 inputs and 16 outputs, or variant C for 28 inputs and 20 outputs.

The 16K-byte CMOS main memory is a redundant memory for periods of power failure. It has an access time shorter than 950 μsec and a write-and-read cycle shorter than 1.1 μsec.

The 64K-byte NMOS + 16K-byte EPROM combined memory is an autonomous (except for the power supply) universal memory module that permits the recording, storage and reading of data and also the storage of firmware. The RAM part has an access time shorter than 420 nsec, and a write-and-read cycle shorter than 550 nsec.

The EPROM part has an access time shorter than 500 nsec. The combined memory is designed on a single 2/3 SMEP board that replaces four 2/3 boards each with 16K bytes of RAM, and one 2/3 board with 16K bytes of EPROM. This is an advantage in terms of space and power consumption.

The 8K-byte static RAM + 8K-byte EPROM combined memory is similar to the preceding combined memory, except that its capacity is lower. This combined memory has been developed for special applications. Further details are not available as yet.

The programmable parallel adapter module permits connecting up to 72 peripherals by means of a parallel communication line. It contains three programmable parallel circuits that can operate in three different modes. Each circuit contains 24 lines, subdivided into three channels with eight lines each, designated as channels A, B and C. In the 0 mode the first two channels function as either input or output channels, while channel C can be used for four inputs and 4 outputs. The output channels operate with a register; the input channels, without a register. In the 1 mode, two groups of channels are used: an 8-bit data channel (A or B) and a four-bit control channel (1/2 C). Both can be either input or output channels, and both operate with a register. In the 2 mode, channel A is a two-way 8-bit data channel, and channel C is a 5-bit control channel. The data channel has an input and an output register. A combination of the individual modes can be selected during programming. The interrupt module handles 10 interupt requests: 6 from the parallel circuits, 3 external ones from peripherals, and 1 from the timer module that generates signals with pulse widths of 0.5, 1, 2 and 4 msec.

The analog-to-digital converter module permits the rapid and accurate conversion of analog signals from the low- or high-level multiplexer to which it is connected in tandem, into digital code that enters the microprocessor through the bus. A 12-bit converter with a sample and hold amplifier is used. Conversion time is 50 μsec with the high-level multiplexer, and 200 μsec with the low-level multiplexer. Depending on the number of circuit boards used in the multiplexer, the number of inputs can range from 16 to 256.

The low-level multiplexer module makes it possible to connect up to 16 inputs for low-level (low-voltage) signals from various locations in the environment. It passes these signals on to the analog-to-digital converter module for conversion.

The high-level multiplexer module permits the connection of up to 32 inputs for high-level signals from various locations in the environment. It passes these signals on to the analog-to-digital converter module for conversion.

The counter input module evaluates the pulse signals arriving from the environment to the microcomputer, when the information carrier is the number or frequency of the pulses. Its 16-bit counters can be set in advance to input and reset upon overflow, according to four possible modes of operation.

The pulse output module generates at its eight outputs to the environment pulse signals with the programmed number of pulses or with the programmed pulse width. The module contains eight eight-bit counters. It also generates a sign to indicate the nature of the output (increment, decrement).

The interrupt input module receives up to 32 inputs of asynchronous signals from the environment into the microcomputer. These signals require immediate processing and response from the microcomputer.

Possible Configurations

The basis of each configuration is a single or double housing for five or ten modular 2/3 SMEP boards, together with fan and power supply. The power supply is designed in three variants. Type A permits interconnecting the modules in the housing for standard applications and is a part of every configuration (for example, memory modules, programmable adapters, etc.). Type B is intended for interconnecting the modules for communication with the environment. The type C power supply is used in the configuration of the MVS (Microcomputer Development System).

The manufacturer gives the following examples of these configurations:

For data acquisition:

--Housing with type A power supply;

--SM 2138 processor;

--SM 0440 16K-byte RAM module;

--SM 2165 programmable adapter module;

--SM 7202 CRT display with keyboard;

--Nonstandard interface module;

--FS 1501 A/M punched-tape reader;

--DT 105 S tape punch;

--Consul 2111 matrix printer.

For process control:

--Housing with type A power supply;

--Housing with type B power supply;

--SM 2138 processor;

--SM 0449 16K-byte EPROM module;

--Eight-bit analog output module;

--Twelve-bit analog output module;

--Optically isolated discrete input/output module.

MVS for development of applications software:

--SM 1601 simple CRT terminal with keyboard;

--Housing with type A power supply;

--Housing with type C power supply;

--SM 2138 processor;

--SM 0440 16K-byte RAM module;

And either:

--Nonstandard interface module;

--FS 1501 A/M punched-tape reader;

--DT 105 S tape punch;

Or:

--External floppy-disk memory module.

MVS (Microcomputer Development System)

In addition to the mentioned punched-tape and floppy-disk memory versions, the Microcomputer Development System can be equipped also with a 16K-byte EPROM, a circuit emulator and a memory programmer.

The MVE 80 circuit emulator consists of an SM scanning module and a PME emulator processing module. The scanning module records four-bit data for each computer cycle in the course of emulation. It contains circuitry for communication with the system and for interrupting the emulation. The emulator's processor module is based on an I 8080 circuit that during emulation executes the user program's instructions and the instructions of the ROM-stored program for controlling the emulator. It contains circuits for controlling the MVS bus and the user's bus, and it starts and ends emulation.

The PGM 08 simple memory programmer can program the PROM and EPROM memories and read their content. It is designed in a separate cabinet with its logic and power supply, and it is connected to the MVS by means on an IRPR communication cable.

MVS is intended for the development and testing of application programs for systems whose design is based on the I 8080 microprocessor. It permits checking the system, and the programming and copying of EPROM.

Interactive Terminal

The interactive terminal enables the personnel to communicate with the computer system. It is suitable for data acquisition and preprocessing in process control, or as an office or store terminal, and for handling reservations and registrations (for example in passenger transport, hotels), etc. The largest configuration tested included the following:

--A supervisory terminal based on the SM 50/40-1, installed in an alphanumeric CRT terminal with keyboard;

--Three SM 1601 simple monitoring CRT terminals with keyboard;

--A minimum of 32K bytes of RAM;

--An external floppy-disk memory with a capacity of 512K bytes;

--A matrix printer.

To the supervisory terminal it is possible to connect five devices through the IRPS or S 2 serial communication line, and four devices through the IRPR parallel communication line. Of the five serial channels, one is used for communication with the master computer, one for connecting the CRT of the supervisory terminal, and three for connecting the SM 1601 terminals.

Of the parallel channels, one is used for the matrix printer, and the other three can be used for communication with additional peripherals (punched-tape reader, etc.).

Word Processing System

The word processing system is a user-oriented system that does not require any special knowledge of programming microcomputers. It has programs for the complete entry of text that is successively stored in the external memory, without any further intervention. From the external memory the text can be recalled into the main memory, edited and changed, etc. The final text is then printed out on a printer. The text can be printed any number of times and can also be reformated.

The core of the word processing system is the SM 2138 microcomputer, to which the following peripherals are added:

--A standard alphanumeric keyboard (similar to a typewriter keyboard) for entering the text and operating the entire system;

--A visual display unit for displaying the text and the instructions for the user;

--A serial printer for printing the text, with punctuation marks and upper and lower case letters;

--A disk or tape unit for recording and storing the text and for file maintenance in an appropriate external memory.

The system software consists of six basic modules:

--Keyboard utility program;

--Display unit utility program;

--Buffer memory utility program;

--Disk or tape unit utility program;

--Printer utility program;

--Program for guiding the user.

Software for SMEP Microcomputers

The real-time executive routine (ERC) system is the basis for the practical application of the SM 50/40-1 module. It is intended for designing systems operating in real time. It permits the simultaneous processing of several independent tasks on the basis of priorities, the handling of interrupts, and the organization of communication between tasks and between the microcomputer and its

external environment. The tasks may be system tasks for standard operation of the modules, or they can be written by the user for his specific applications. The real-time executive routine requires not quite 2K bytes of ROM and performs the following functions:

--System startup;

--Control and synchronization of the running of the tasks;

--Timing the system;

--Exchange of data within the system.

The DOS MVS operating system is disk-oriented and consists of an entire complex of system programs that are entered in the memory only when needed. For the part that must be permanently entered in the memory, about 12K bytes of memory capacity are required. DOS MVS uses a series of monitor subprograms that must be stored in the memory and require about 2K bytes of EPROM.

The macroassembly program converts the source program, written in symbolic language (assembler), into machine instructions. It can be used with the punched-tape and disk versions.

The PL/M programming language is a higher programming language of the Algol type, for microcomputers. It can also serve as a real-time language. The compiler requires 32K bytes of RAM and a floppy disk, and it operates under DOS MVS. The program in PL/M can be segmented into separate modules, and these can then be assembled for the object program.

The text editor permits the use of all characters of the ASCII keyboard and requires 3.5K bytes of RAM.

The MIKROS microcomputer operating system has been developed for so-called office computer applications. It is simple and independent of the hardware. It permits further operation with add-ons within the framework of the system software and user software. Implementation of MIKROS is feasible in every I 8080-based microcomputer if it has a capacity of at least 20K bytes of RAM.

The MUOS multiuser disk operating system has been developed for the terminal. It permits more efficient utilization of the microcomputer while requiring less than 13K bytes of memory. Besides the macroassembly program, the most important user programs are the text editor, the TL higher-order programming language, and programs for managing disk files. TL language requires 64 K bytes of memory.

L Pascal is a high-level programming language derived from Pascal and adapted for use with the Microcomputer Development System. It is suitable for writing application programs. The compiler's operation is controlled by OS MIKROS. The possible applications will be expanded with the introduction of floating-point arithmetic, structures and standard procedures.

Graphic instructions are being added to P-Basic language. This will permit its use in the SM 50/40-1 system with semigraphic display.

Only deliveries of the punched-tape version are planned from series production in 1982, including 36 SM 50/40-1 and 20 MVS systems. Already 300 systems are expected to be produced in 1983, and 400 in 1984.

1014
CSO: 2402/70

MINICOMPUTERS SM 3-20 AND SM 4-20 DESCRIBED

Prague VYBER INFORMACI Z ORGANIZACNI A VYPOCETNI TECHNIKY in Czech No 3, 1982
pp 281-288

[Article: "The SM 3-20 and SM 4-20 Minicomputers Offered in 1982 by the Kancelarske Stroje (Office Machines) Special-Purpose Concern Organization"]

[Text] SM 3-20 Minicomputer Produced by the Namestovo Plant of ZVT [Computer Technology Works], Banska Bystrica

The SM 3-20 is a modern, word-oriented, 3.5-generation minicomputer with a 32K-word semiconductor memory. It is characterized by its modular design, which permits simple and flexible system configurations for the following applications:

--Scientific and engineering computations;

--Data acquisition and subsequent processing, for smaller organizations;

--Applications for physics laboratories and measuring stations;

--Automation of scientific experiments, control of laboratory experiments;

--Applications in education;

--Economic and statistical computations of small volume;

--Applications in agriculture, health care, etc.

The SM 3-20 minicomputer can be used also to write and debug programs for other SMEP [System of Small Electronic Computers] systems (for example, the SM 4-20) with which it is upward compatible, or for an expanded configuration of the SM 3-20 that the user might want in the future.

Basic Hardware Configuration

Designation	Characteristics
SM 3-20	The SM 3-20 minicomputer in the following configuration: --CM 2301 processor, the basic module (including a load module, a simple timer, and all the adapters for connecting the peripherals listed under this item); --A 32K-word semiconductor main memory; --CM 6204 SPTP/3 tape reader/punch module; --CM 5105 disk controller (permits connection of up to four drives for the IZOT 1370 disk cartridge); --CM 5400 disk cartridge drive, 2 x 2.5M bytes, IZOT 1370;

--CM 7202 video monitor with keyboard, screen 25 lines by 80 characters, maximum transfer rate 9600 bps;

--CM 6301 matrix printer DARO 1156;

--CM 5300 tape controller, permits connecting up to four standard tape drives;

--External memory with standard magnetic tape, 9 tracks, 800 bpi, length 1200 feet;

--Two standard SMEP racks with power supply, cages, cables, etc.

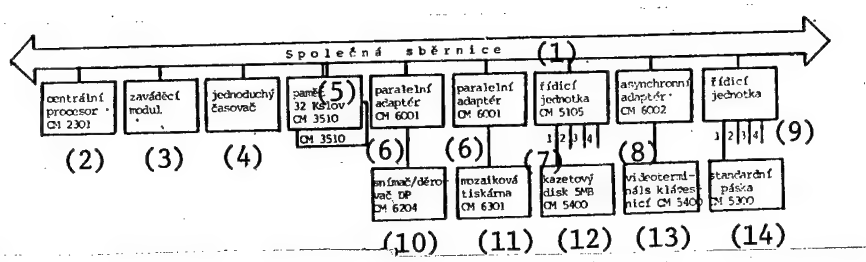

Figure 1. Basic configuration of the SM 3-20.

Key:

1. System bus
2. CM 2301 central processor
3. Load module
4. Simple timer
5. CM 3510 memory 32K words
6. CM 6001 parallel adapter
7. CM 5105 controller
8. CM 6002 asynchronous adapter
9. Controller
10. CM 6204 tape reader/punch
11. CM 6301 matrix printer
12. CM 5400 cartridge disk, 5M bytes
13. CM 5400 [sic] video monitor with keyboard
14. CM 5300 tape controller

The basic hardware configuration of the SM 3-20 minicomputer (Fig. 1) can be expanded by adding the optional modules, with their adapters, listed below. In terms of the number of ports in the system bus and from the viewpoint of the number of interface cards that fit into the cages of the two racks, the configuration may be expanded by adding more than 10 devices, using an extension to the system bus and plugging in additional interface cards. However, only 7 of these 10 additional devices can be used simultaneously (due to the limitations imposed by the operating system).

SM 4-20 Minicomputer Produced by the Namestovo Plant of ZVT, Banska Bystrica

The SM 4-20 is a modern, word-oriented, 3.5-generation minicomputer, the most powerful model in the SMEP I series.

It is fully upward compatible in its software with SM 3-20 minicomputer but has the following advantages over the latter:

--An expanded set of instructions;

--Larger input/output handling capacity;

--A wider range of applications, in view of the 256K-byte main memory and more powerful operating systems.

The SM 4-20 minicomputer is suitable for controlling scientific and engineering experiments and measuring stations, for processing laboratory data, for the acquisition of data from multiterminal systems, for bulk data processing, for continuous and noncontinuous process control, for setting up information systems and managing data banks, for controlling computer networks, etc.

The minicomputer is of modular design, on the building-block principle. Its basis is the system bus to which the processor with the memory, and all other devices, including peripherals, are connected uniformly. Therefore to an installed system it is possible to add later any SMEP module.

Basic Hardware Configuration

Designation	Characteristics
SM 4-20	The SM 4-20 minicomputer in the following configuration: --CPU with 256K-byte memory (includes CM 2401 basic processor, a load module, a floating-point processor, CM 2001 programmable timer, CM 5105 disk controller which permits connection of up to four drives for the CM 5400 disk cartridge, CM 5300 tape controller for up to four magnetic-tape memories, CM 6002 asynchronous adapter for the CM 6002 video monitor, and CM 6001 parallel adapters for the CM 6204 punched-tape peripheral and the CM 6301 printer); --Two CM 5400 disk-cartridge external memories (Bulgarian designation IZOT 1370) with a capacity of 5M bytes each; --CM 5300 standard magnetic-tape memory (IZOT 5004, Bulgaria), 9 tracks, density 32 bits/mm or 800 bpi; --CM 6204 tape reader/punch module (STP/3, Poland), maximum reading rate 500-1000 cps, maximum punching rate 50 cps; --CM 7202 video monitor with keyboard, screen 25 lines by 80 characters or 1920 characters/screen, maximum transfer rate 9600 bps, serial interface; --CM 6301 matrix printer (DARO 1156, East Germany), speed 100 cps, 178 characters per line; --Two standard SMEP racks with power supply and cables.

The basic hardware configuration of the SM 4-20 (Fig. 2) likewise can be expanded with optional modules and appropriate adapters, listed below. In the processor's cage and in the expanding cage of the second rack there are empty slots for the interface cars of the added peripherals that the operating systems are able to support.

Expansion Modules

The following expansion modules will be available, in limited quantities, for the SM 3-20 and SM 4-20 minicomputers:

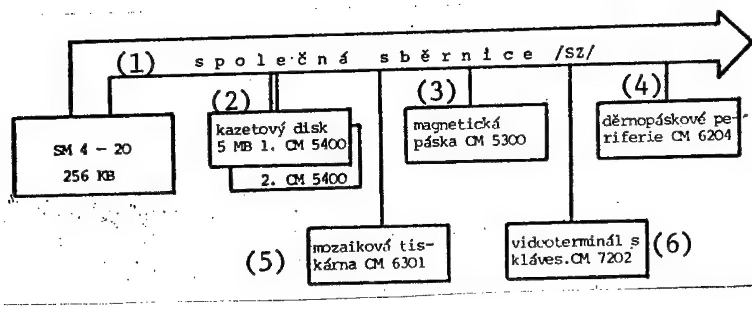

Figure 2. Configuration of the SM 4-20 minicomputer.

Key:

1. System bus
2. CM 5400 cartridge disk, 5M bytes
3. CM 5300 magnetic tape memory
4. CM 6204 punched-tape peripheral
5. CM 6301 matrix printer
6. CM 7202 video monitor with keyboard

Type	Characteristics
CM 7202 serial	Alphanumeric video monitor with keyboard and serial interface
CM 7202 parallel	Alphanumeric video monitor with keyboard and parallel interface
CM 6301	DARO 1156 matrix printer with parallel interface, suitable also for connecting to the CM 7202 video terminal for obtaining hard copy
CM 6204	SPTP/3 tape reader/punch module with parallel interface
CM 6208	CONSUL tape reader/punch module, reading rate 300 cps, punching rate 55 cps, parallel interface
CM 6002	Asynchronous serial adapter ASAD, necessary for connecting serial interfaced equipment to the system bus, either --with four-wire IRPS communication line up to a distance of 500 m, or --before a modem with a CCITT V.24 interface, without any restrictions on distance; for example, over the telephone network (modems MDS 1200 are supplied by ZVT, Banska Bystrica)
CM 6001	PAD-8 parallel adapter for connecting equipment with a parallel interface to the system bus, up to a distance of 15 m
CM 6003	PAD-16 parallel adapter for connecting 16-bit parallel interfaced equipment to the system bus
CM 8105	Zero modem for connecting locally, within a range of several tens to several hundreds of meters, equipment that has a serial interface per CCITT V.24

CM 5400	5M-byte cartridge disk memory (IZOT 1370)
CM 5605	MOMFLEX 6400 (Hungary) external floppy-disk memory with controller and twin drives, total capacity 512K bytes
CM 5300	External standard magnetic-tape memory
EC 6112	ARITMA 2050 punched-tape reader with controller, for SMEP
CM 9004	Controller for connecting JSP-DASIO unit for communication with the environment (JSP-DASIO = CM 9101, supplied by METRA, Blansko)
CM 9205	LJSP laboratory unit for communication with the environment
CM 1601	Simple alphanumeric video terminal, 16 (12) lines, 64 (40) characters per line, serial interface, maximum transfer rate 9600 bps
CM 8606	SAD serial synchronous adapter for synchronous interconnection of SMEP computers or interconnection with JSEP [Unified System of Electronic Computers], transfer rate up to 9600 bps, cyclic code protection, V.24, V.28 interface
CM 4103	System bus repeater for configurations where physical length of the bus exceeds 15 m or the total number of connections to the bus exceeds 18; can be installed to function also as UBM [universal connection unit]
CM 5300	Controller for connecting one to four standard magnetic-tape drives IZOT 5004 (Bulgaria)
CM 0102	Interface for IMS-2 [integrated measuring system], intended for connecting the measuring system's instruments
Expansion cage	Cage for installing the additional interface and adapter cards that do not fit into the processor's card cage
Rack No 168	The SMEP minicomputer rack intended for the insertion of the expansion modules that do not fit into the existing racks; it contains a cage with two universal connection units, power distribution and power supply
Rack No 160	Free-standing rack suitable for housing cages or additional expansion modules (for example, CM 5605, CM 5300, CM 5400)

Software

Software for the SM 3-20 Minicomputer

The described SM 3-20 system comes with the FOBOS-1 operating system, free of charge. It is a two-program or one-program operating system for one user. Languages: Macroassembler, Fortran IV, and Basic. The fee for this basic operating system is included in the price of the hardware.

Also available is the LOS punched-tape system. This is a small operating system for a single user. Languages: Assembler, Basic and Fokal. It contains a number of utility programs, and a set of programs for floating-point operation.

The special-purpose software includes the following:

VU Basic permits the simultaneous operation of up to eight user terminals in a star-connected network, in Basic language.

VYUKA (Instruction) is an operating system that likewise permits simultaneous operation by up to eight users. Its applications are in the field of education.

The PPPD-1 system is intended for the preparation and preprocessing of data from eight operator consoles, with the feasibility of converting the data into EBCDIC code for further processing on JSEP computers. It is supported by the FOBOS operating system on the basis of VU Basic. In the PPPD-1 system it is possible to efficiently prepare and preprocess data by means of the supplied standard software. For special requirements the programs can be modified or written to order.

The PPPD-1 system

--Can be simply adapted to the specific hardware configuration during generation that takes place in the form of a dialogue with the system programmer;

--Is code-protected against unauthorized access;

--Maintains statistics on its own operation;

--Permits the use of various forms, with or without headers;

--Guides the operator during data acquisition, performs a formal check of the correctness of the data, permits work with the headings and regular lines of a form, and stores the data on a disk;

--During the updating of data entered earlier, it can search and find a sentence, edit it, insert new sentences and delete data;

--It can verify data by comparing new entries with original files;

--It can merge batches of data;

--Copies data from the disk onto magnetic tape and converts the ASCII code into EBCDIC code, in a format suitable for processing on individual models of the JESEP computers.

With certain limitations, operating systems intended for more advanced SMEP models may be used on the SM 3-20 minicomputer. These are:

MOS RV V 2, a small multiprogram operating system (the so-called unmapped version) for real-time operation. Languages: Macroassembler and Fortran IV.

DIAMS-1 is an interactive operating system with time-sharing, for several users. Language: Mumps.

For services related to the distribution of the mentioned expansion software (program maintenance, system generation, training of personnel), the user is charged for the costs, in accordance with the regulations that are in force.

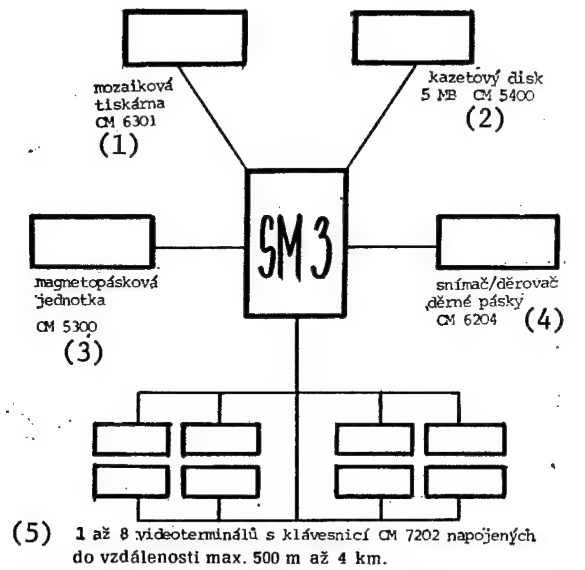

Figure 3. The PPPD-1 System.

Key:

1. CM 6301 matrix printer
2. CM 5400 cartridge disk, 5M bytes
3. CM 5300 magnetic-tape unit
4. CM 6204 tape reader/punch
5. From 1 to eight CM 7202 video terminals with keyboard, connected within a distance of 500 m to 4 km

Software for the SM 4-20 Minicomputer

DOS RV V2 is the standard multiprogram operating system in real time that is supplied with the SM 4-20 minicomputer. The system permits the separate or combined processing in real time of problems that have a high priority, and require fast response to external events, together with less urgent problems of considerable volume, in the time-sharing mode. The method of allocating memory, fast cooperation with the external disk memory, the dynamic compression of memory, and a system of priorities ensure highly efficient processing of the problems. The system is protected against unauthorized access, and the individual files likewise are protected. The maximum number of simultaneous problems is 256.

Languages: Macroassembler, Fortran, Fortran IV, PLUS, Cobol, Basic, and PLUS 2.

The operating system supports also the following special-purpose software:

--RSZ system is a system for managing data and record-oriented files, organized sequentially, randomly or according to the index method;

--DTS is an interactive interrogation system for the handling, selection and printing of record-oriented data;

--SORT is a program for sorting record-oriented files;

—SYRPOS is a system for the management of computer and terminal networks on the basis of an SMEP minicomputer (SM 4-20 or SM 3-20). It ensures communication between the computers and terminals, remote data processing, remote control of the problems, file management, access to remote files, etc.;

--SM GRAF is a set of programs for the developed CM 7405 graphic display terminal, in Fortran language;

--Sets of programs for scientific and engineering computations;

--MTD is a program for creating magnetic tapes in any desired format (JSEP, ANSI, etc.).

The developed DOS RV V2 data base system is not available for the time being.

The operating system, including Macroassembler, Fortran and Basic languages, is being supplied free of charge. The cost of distribution--i.e., of generation, program maintenance, training the personnel, etc.--is included in the price of the hardware. Other languages and special-purpose software are supplied on order, with a charge for distribution.

Other operating systems are:

DIAMS-1 operating system permits the formation of simple data bases and informations systems in the dialogue mode, suitable merely for a limited circle of applications. It has file protection. The maximum number of users is 40. Language: MUMPS.

DOS RVR is an operating system with time-sharing. It is able to process transactions and is suitable for bulk data processing. It also has file protection. The basic mode for up to 24 users is the conversational mode in Basic PLUS, and it may be possible to assemble with this language the problems in Fortran IV and Cobol.

FOBOS-2 is an operating system similar to FOBOS-1, but it is intended for computers that have up to 128K words of memory.

PPPD-2 is available for the acquisition of data from up to 32 terminals, to provide the necessary format, arithmetic and logic control, communication, sorting, printing and conversion functions, to maintain operational statistics, to provide a link to JSEP computers, etc.

These other operating systems will be supplied on special order, for a distribution fee.

The FOBOS, VU BASIC, VYUKA, PPPD-1 operating systems, and the unmapped version of MOS RV V2 (a subset of the aforementioned DOS RV V2) that are intended for the SM 3-20 minicomputer, including all the programs written in them and debugged, can be run also on the SM 4-20 minicomputer.

Documentation

A complete set of the technical and software documentation, numbering scores of titles, is supplied with all the hardware and software.

Deliveries

Similarly as other SMEP systems, the SM 4-20 and SM 3-20 minicomputers are subject to the state material balance. In view of the three-year balancing cycle, computers are being delivered in 1982 that were balanced in 1979, and in 1982 the balance is closing for 1985. The SM 4-20 minicomputers that are to be supplied in 1983 and 1984 have already been allocated from the balance.

In view of the fact that the balance for SM 3-20 minicomputers is not full at present, an additional balance and delivery of this computer can be requested for 1983 and 1984.

Training

The training section of Kancelarske stroje (Zitna 32, 120 000 Prague 2) centrally ensures the necessary training of technicians, programmers and operators for all the supplied hardware and software. After perusal of the schedule of courses offered by this section, the customer may requests forms of obligatory orders for enrollment in the individual courses. The employees are then trained on the basis of these orders.

Installation

Systems are installed on the basis of special orders. The premises in which a system is to be installed must meet the specifications for the construction of computer centers. Since magnetic storage media are used, air conditioning is necessary. The system requires a separate power line that must be grounded ($<4\Omega$).

Warranties

There is an extended warranty of one year on all hardware and software, from the day of the system's acceptance, but not more than 15 months from the date of delivery.

Service

After the warranty period, technical servicing must be performed by the user's personnel. As assistance to ensure servicing by the user, Kancelarske stroje will provide laboratory support to recover damaged disks on an exchange basis, and it will also keep in stock the replacable modules.

Information

The individual professional sections of the appropriate regional office of Kancelarske stroje will provide information on deliveries of hardware and software, on service, and on the construction of computer centers.

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CSO: 2402/70

QUANTUM JUMP IN NUCLEAR HIGH TECHNOLOGY DESCRIBED

Warsaw ZYCIE WARSZAWY in Polish 29 Jul 82 p 3

[Article by Bozena Kastory: "A Polish Nuclear Fuel Patent"]

[Text] This is the story of the patent. It is sufficient that the Italians are selling two industrial installations built in accordance with a Polish idea, and the money spent on this work by the IBJ [Institute of Nuclear Research] will be paid back in its entirety over a period of a dozen years or so. It is not that the patent holders received several thousand zlotys each. "The concern is not about money," states Prof Przemyslaw Hoffman, director of IBJ Department XXII. "It is the satisfaction that we can compete with the world's industrial giants. And compete in what? In equipment for nuclear energy, specifically the regeneration of nuclear fuel. They have several dozen nuclear power plants; we have none. When extractors to regenerate nuclear fuel were built at the IBJ, it was necessary to test them under high-activity conditions... But in Poland hot cells were actually eliminated from the investment plans, and it was not possible to check out the extractors."

"Who should we approach? Those who produce nuclear bombs--such as the United States, England or France--do not permit foreigners to participate because of state secrets, military affairs and the like. In the field of nuclear fuel regeneration, the IBJ investigates many subjects jointly with Soviet institutions, but expanding research on extractors was limited by the size of available experimental installations... The smallest extractor developed by the Polish team has a regeneration capacity of 3 kg of nuclear fuel per hour. Is that much? It is very much. The disintegration energy of one gram of uranium-235 isotope corresponds to 1 megawatt-day or 1 million watts for an entire day. That much just from one gram of fissionable material! But the smallest-capacity extractors developed by the IBJ can regenerate 3 kg of spent fuel per hour which contains not 1 but 10 grams of the fissionable uranium-235 isotope and about 6 grams of plutonium-239.

"We began searching abroad for the industrial capability to test our extractors. Two potential candidates, the FRG and Italy, replied. We selected Italy because I first began work in this field in 1967 during my stay of several months in Italy. An agreement was signed between the then existing UEJ [Nuclear Energy Administration] and the National Committee on Nuclear Energy in Italy."

Why do we make equipment to regenerate fuel when we do not have a single nuclear power plant?

First of all, when Professor Hoffman and his people started their work Polish programs projected that Poland's power industry would develop much sooner. In addition, coal resources would not last too long. In the 1990's we will have to obtain energy from uranium. However, by that time the world will be exploiting secondary deposits which are now considered to be unprofitable; such deposits contain no more than 0.1 to 0.2 percent uranium.

In the meantime, in the spent fuel from nuclear power plants about 92 percent of the uranium as well as several grams of plutonium for each kilogram of fuel used is left behind. This is a specific of nuclear reactors as opposed to conventional oil- and coal-fired power plants where all the fuel is burned in one cycle. In a nuclear power plant, 98 percent of the fuel remains in the spent fuel. It should be regenerated, that is, the uranium and plutonium should be separated from the products of fission in order to return the fuel to be burned again. The separated products of fission are radioactive wastes, dangerous to living organisms. They simply cannot be thrown away, thrown into a river or dumped into the ocean. They must be stored in special containers for several years until they cool down, that is, until the short-life radioactive elements decay. Long-life elements will remain at any rate.

Transporting spent fuel to regeneration plants in densely populated Europe is dangerous. It would be best to regenerate them on site. Of course, this is not easy to do. If it were easy, everyone would be doing it now. The very high activity of the spent fuel makes it difficult to extract the uranium and plutonium. Thus it is necessary to conduct operations at a distance, remotely controlled, using completely reliable apparatus because direct human intervention is not possible. One must "breed" robots coupled to electronic brains which could operate within a hot cell, something no living person can do. These robots will have to evaluate the situation, make a diagnosis, make a decision and operate in these cells.

To what extent is the IBJ involved in this work?

"We developed a concept;" states Professor Hoffman, "for a two-stage fuel regeneration process. The first, hot stage for regenerating fuel, that is, dissolving it in acid and extractively separating the uranium and plutonium from the products of fission, would be conducted on site at the large electric power plants. Then the uranium and plutonium mixture would be transported to a central plant where the uranium and plutonium would be separated out under international control. Why can they not be used again by the same nuclear power plant? Because they contain plutonium from which nuclear bombs are made. So long as plutonium is mixed with uranium it cannot be bomb material. Plutonium by itself is bomb material.

"At the IBJ we are involved with the first, hot stage of regeneration. We are developing flow-line production equipment, control components and automation equipment. Thus we made the original equipment to dissolve the fuel as well as a whole family of extractors to separate the uranium and plutonium

from the products of fission. The smallest extractor, as already mentioned, has a production capacity of 3 kg of fuel per hour, and the largest has a capacity of 200 kg of fuel per hour. These physically small devices have very large capacities and phase contact time is much shorter then in devices used to date. Thanks to their small size, there is no danger of exceeding the critical mass or of an uncontrolled explosion. Miniaturization of these devices decreases the cost of the very expensive concrete shields. The amount of active solutions in the devices also are decreased greatly, and thus the danger of contaminating the environment in case of failure is also decreased.

"Control is another matter. Ordinarily, the analytic control used in slowly occurring processes proceeds as follows: first, a sample is taken, it is then placed in an analysis chamber where the uranium and plutonium contents are determined. With fast processes, however, this would be only a record of what was, without the possibility of affecting the process. On-line control is needed here. Therefore we developed an on-line control device to determine the uranium and plutonium in solutions before and after extraction. Everything will be automated. Data will be processed with the aid of microprocessors.

"You ask, what projects are near completion? We are on the verge of completing the extractors. An entire battery is ready which will be installed in hot cells in plants in Trisaia, Italy. It will be a test--1,000 hours spent regenerating fuel. After this test, the extractor will become a commercial item. The Trisaia plant is specially designed for such testing. It is very adaptable, it has the capability of modifying specific equipment while in operation. Allowing us into the plant is a great opportunity for us. Our people are being trained in the best plants. But what about our intellectual input? Did you know that the Italians are spending $20 million for this purpose. From our side it is mainly the technology that is worth the money. Tests have already taken place at the Trisaia production flow-line facilities with uranium and thorium. All theoretically possible accidents and how to avoid them as well as a full cycle of investigations were also conducted for the safety report."

The IBJ Department XXII team is the author of the patent. The concept and initial development are Professor Hoffman's. Then came the implementation and improvements. During the course of the project, modifications were made jointly with the Italians. The Polish patented equipment will be jointly patented with the Italians because of the many important modifications. They will be produced in Italy.

Is this better or worse for us?

"We could not manage to do it by ourselves. Many materials needed for production and for operations in hot cells are included in the embargo. Now the Italians are waiting for the arrival of Polish specialists to place the Polish extractors into operation in the Italian hot cells to regenerate spent fuels in the Trisaia plants. With each installation sold by the producer,

5 percent of the proceeds goes to Poland and 5 percent to the Italians. There are willing buyers. There are several such extractors in the world to regenerate fuel. The Polish one is the simplest and thus the most reliable.

"It is not megalomania," states Professor Hoffman. "One cannot learn about equipment, one has to have a feel for it. I was born in a factory. My father also spent his entire life in factories. I have worked with machines for many years. I understand them, have a feeling for them. I am not ashamed to say that machines and equipment are my passion. In the 1950's I directed the team that developed the granulated superphosphate technology. Later, in Tarnobrzeg, we developed the technology for sulfur modification, flotation and smelting. And when work started at the IBJ on applying radioactive isotopes to investigate industrial processes, I was asked to participate in the work. Then I was asked to organize a laboratory which would be involved with nuclear-fuel regeneration. This process requires equipment of the highest technology--it must be reliable and sophisticated, and that is what attracted me."

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